APPENDIX B
VERSION WITH MARKINGS TO SHOW CHANGES MADE
37 C.F.R. § 1.121(b)(iii) AND (c)(ii)

SPECIFICATION:

Attached hereto is a marked copy of the original specification showing the changes made.

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MOVING PICTURE DECODING APPARATUS
AND MOVING PICTURE DECODING METHOD (Marked Copy)

BACKGROUND OF THE INVENTION

The present invention relates to a moving picture decoding apparatus, and

5 especially, to a moving picture decoding apparatus capable of reducing a necessary

capacity of a frame memory to be used when coded moving pictures are decoded.

Conventionally, this kind of a moving picture decoding apparatus is used [as]

in a method for reducing a necessary frame memory capacity used in the decoding

process. As the conventional moving picture decoding apparatus, [in]

10 JP-A-261635/1997, for example, [as] discloses an arrangement for reducing a frame

memory capacity necessary for storage or reference images and re-ordering decoded

images, [an arrangement is disclosed,] which comprises a data compression circuit

for compressing a decoded image and a data expansion circuit for expanding [a]

compressed data. Also, in JP-A-247673/1997, an arrangement is proposed[,] in

15 which a set of moving pictures data of which data content has been reduced by data

content reducing means for reducing [a] data content of [a] data read from the frame

memory is restored by data content restoring means.

Also, in JP-A-4550/1998, for example, an apparatus is proposed[,] in which

[memory] a reduction in memory use capacity is facilitated using Adaptive

20 Differential Pulse Code Modulation (ADPCM). In the apparatus described in the

publication, compression is conducted by estimating a change [of] in each block of

n x m pixels compressed using orthogonal translation, encoding a first pixel of each

block with p bits in accordance with the ADPCM method, encoding an estimated

value of the change with n x h bits, and further, encoding a difference value between

[other] each pixel following the first pixel and an average value of all pixels in the [blocks] block with p-k bits.

However, in the conventional moving picture decoding apparatus proposed in the above-described JP-A-4550/1998 and so forth, [of] in which the objective is to

5   reduce the capacity of [the] frame memory used, there is a [task] problem in that efficient access to the memory cannot be realized.

The reason [thereof] for this is that an access width of the memory is not [at all] taken into account in a memory compression and expansion section of the above-described moving picture decoding apparatus.

10   SUMMARY OF THE INVENTION

[The] An objective of the present invention is to solve the above-mentioned problem.

Also, [the] another objective [thereof] of the present invention is to provide a moving picture decoding apparatus for reducing the capacity of a frame memory

15   necessary to be used when an image is decoded by [means of] a compression operation and accomplishing the compression and expansion processing of a memory content with [a] high speed, and further, for decoding an image with high quality.

[For solving] To achieve the above-described objective, the moving picture decoding apparatus of the present invention, to which a compressed stream generated

20   using an inter-frame prediction system is input, comprises compression means for compressing a decoded image when the signal is stored in a memory, expansion means for expanding a compressed image stored in the above-[described] mentioned memory, quantization means for controlling quantization on compression in the above-described compression means, and access width control means for controlling

25   the above-described quantization control means so that [an] information content for a single or a plurality of memory compression processing units or for every control

unit [of] <u>is a</u> memory compression [processing] <u>process</u> is in conformity with the [bit] number <u>of bits</u> of an access unit of the above-[described] <u>mentioned</u> memory.

In the moving picture decoding apparatus of the present invention, said access width control means comprises means for controlling said quantization control means so that the coded [bit] number <u>of bits</u> for a single or a plurality of compression processing units or for every control unit of compression processing is in conformity with the [bit] number <u>of bits</u> of an access unit of said storage means in <u>the</u> case that the coded [bit] number <u>of bits</u> exceeds the [bit] number <u>of bits</u> of an access unit of said storage means or is lacking.

Furthermore, in the moving picture decoding apparatus of the present invention, said compression means and expansion means <u>may</u> conduct compression and expansion, respectively, in accordance with a pixel difference prediction encoding system.

Furthermore, the moving picture decoding apparatus of the present invention <u>may</u> further [comprising] <u>comprise</u> a plurality of quantizers and a plurality of quantization characteristic tables.

Furthermore, the moving picture decoding apparatus of the present invention <u>may</u> further [comprising] <u>comprise</u> a plurality of quantizers and a quantization characteristic table being shared by said plurality of quantizers.

Furthermore, in the moving picture decoding apparatus of the present invention, said compression means and expansion means <u>may</u> conduct compression and expansion, respectively, in accordance with an orthogonal translation encoding system.

Furthermore, in the moving picture decoding apparatus of the present invention, said access width control means <u>preferably</u> conducts control using information included in the compressed stream.

Furthermore, in the moving picture decoding apparatus of the present invention, said storage means is <u>preferably</u> a frame memory.

BRIEF DESCRIPTION OF THE DRAWINGS

[This] <u>These</u> and other objects, feature and advantages of the present invention will become more apparent upon a reading of the following detailed description and drawings, in which:

Fig. 1 is block diagram showing an arrangement of a moving picture decoding apparatus of the first <u>preferred</u> embodiment of the present invention;

Fig. 2 is a [view] <u>diagram</u> for explaining the principle of the present invention and [a view] for showing an access bit width and a width of an quantized data;

Fig. 3 is a [view] <u>diagram</u> for explaining the principle of the present invention and [a view] for showing an access bit width and a width of a quantized data;

Fig. 4 is a [view] <u>block diagram</u> for showing an arrangement of a memory compression and expansion section in the first embodiment of the present invention and

Fig. 5 is a block diagram showing an arrangement of the second <u>preferred</u> embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[A form for working] <u>An example</u> of the present invention will be explained. In a [preferable form of working of a] moving picture decoding apparatus [in] <u>of</u> the present invention, compression is applied to a decoded image in a memory compressor (105 of Fig. 1), and [it] <u>the compressed decoded image</u> is stored in a frame memory (106 of Fig. 1). Based on [an] <u>the</u> occupied content [of] <u>in</u> the frame memory (106 of Fig. 1), in <u>the</u> case that the <u>number of</u> coded data [bit number] <u>bits</u> for a single or a plurality of memory compression processing units or for every

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control unit of memory compression [processing] <u>process</u> exceeds the [bit] number <u>of bits</u> of a memory access unit or is lacking, a memory access width control section (110 of Fig. 1) applies control to a quantizer control section (109 of Fig. 1) so that the <u>number of</u> coded data [bit number] <u>bits</u> is conformed to be equal to or less than

5   the [bit] number <u>of bits</u> of the memory access unit.

First, the principle of the present invention will be explained. A decoded image is compressed using <u>one of</u> various compression methods. However, the <u>number of</u> coded data [bit number] <u>bits</u> per compression processing unit[, which] is allocated [by] <u>during the</u> compression operation[, is allocated] based on compression

10   ratio, and the [bit] number <u>of bits</u> of a memory access unit is not taken into account.

It is [assuming] <u>assumed</u> that the [bit] number <u>of bits</u> of the memory access unit is M1 bits, <u>and</u> the <u>number of</u> coded data [bit numbers] <u>bits</u> of [a] <u>the</u> compression processing [unit,] <u>units,</u> which [is] <u>are</u> allocated based on a compression ratio, are N1, N2, N3, ... Nn, respectively, and M1 < N1 + N2 + ... Nn. In this case,

15   [a] coded data of n blocks cannot be extracted through one access. Accordingly, by decreasing the [bit] number <u>of bits</u> allocated by N1 + N2 + ... Nn by N1 + N2 + ... Nn - M1, a llocated [bit] <u>number of bits</u> can be made equal to or less than M1, an allocated bit can be made equal to or less than M1, and therefore, the coded data can be taken out through one access.

20   An example of n = 3 as the n blocks is shown in Fig. 2. By subtracting more than or equal to M2 (M2 = (N1 + N2 + N3) -M1) bits from N1 + N2 + N3 bits, an allocated [bit] <u>number of bits</u> can be made equal to or less than M1.

On the other hand, as shown in Fig. 3, in <u>the</u> case that the allocated [bit] <u>number of bits</u> is less than the [bit] number <u>of bits</u> M1 of a memory access unit, and a

25   frame memory has <u>enough</u> capacity, allocation of the [bit] number <u>of bits</u> of the coded data can be also increased.

In the present invention, on the basis of such [a] principal, the memory access width control section (110 of Fig. 1) applies control of an access width of the frame memory to the quantization control section.

In [a from of working of] the present invention, the memory compressor and memory expander may have an arrangement in which compression and expansion are conducted, respectively, in accordance with DPCM.

In [a from of working of] the present invention, based on access width information from the access width control section, in the case that [a] the generated information content for a single or a plurality of memory compression processing units or for every control unit of a memory compression processing exceeds the [bit] number of bits of a memory access unit, quantization control is conducted by preparing a plurality of quantizers having different quantization characteristics, and a quantization table, and by selecting a quantizer that is adapted to [an] the access width. In this case, an arrangement may be adopted[,] in which one quantization table is shared by the plurality of quantizers having different quantization characteristics. In other words, by variably changing a reference interval of one quantization table in accordance with an obtained quantization characteristic (resolution and so forth), it is possible to obtain the different quantization characteristics while one quantization table is shared.

Also, in [a form of working of] the present invention, the memory compressor and the memory expander may conduct compression and expansion, respectively, in accordance with an orthogonal translation encoding system.

Moreover, in [a form of working of] the present invention, the access width control section may apply access width control to the quantization control section using information included in the compressed stream. Below, a detailed explanation will be made in accordance with [an] a preferred embodiment of the invention.

A [The] first preferred embodiment of the present invention will be explained in detail by referring to the drawings. Fig. 1 [is a view showing] illustrates an arrangement of one embodiment of the present invention.

Referring to Fig. 1, this embodiment is constructed [by comprising] to include a variable length decoder 101, an inverse quantizer 102, an inverse discrete cosine transducer (inverse DCT) 103, an adder 104, a motion compensation section 108, and a memory compression and expansion section 11. The memory compression and expansion section 11 is constructed [by comprising] to include a memory compressor 105, a frame memory 106, a memory expander 107, a quantizer control section 109, and a memory width control section 110.

A compressed moving pictures stream encoded by a system such as ISOIS13818-2 (MPEG-2VIDEO) system is supplied as an input to the variable length decoder 101.

The variable length decoder 101 performs variable length decoding, and supplies a result thereof to the inverse quantizer 102.

The inverse quantizer 102 performs inverse quantization, and supplies a result thereof to the inverse discrete cosine transducer 103.

The inverse discrete cosine transducer 103 transduces a conversion coefficient into an image, and supplies a result thereof to the adder 104.

The adder 104 performs addition of the image supplied from the inverse discrete cosine transducer 103 and a predicted image [supplies] supplied from the motion compensation section 108, and supplies a result thereof to the memory compression and expansion section 11.

The memory compression and expansion section 11 [applies] performs compression and expansion [operation] operations to a decoded image, and supplies it to the motion compensation section 108.

The motion compensation section 108 performs motion compensation based on a motion vector supplied from the variable length decoder 101 and the image supplied from the memory compression and expansion section 11, and supplies the predicted image to the adder 104.

5   The memory compressor 105 of the memory compression and expansion section 11 applies compression to the image supplied from the adder 104, and stores [it] the compressed result in the frame memory 106.

The memory expander 107 extracts the compressed image from the frame memory 106 and expands it, and supplies [it] the expanded result to the motion

10   compensation section 108.

The quantization control section 109 applies control [for] of quantization of the image to the memory compressor 105 and the memory expander 107.

The access width control section 110 applies control to the quantization control section 109 using information of the frame memory 106 so that [an] the

15   information content for a single or a plurality of memory compression processing units or for every control unit of the memory compression [processing] process is conformed to be equal to or less than the [bit] number of bits of a memory access unit.

As the compression encoding method in the memory compressor and the

20   memory expander, any of pixel difference encoding, adaptive pixel difference encoding, DCT translation, Hadamard translation, and Wavelet translation and so forth, for example, [are] may be used.

Fig. 4 [is a view showing one] illustrates an example of an arrangement of the memory compression and expansion section 11 [in one] according to the

25   embodiment of the present invention [in]discussed herein, in the case that the memory compressor 105 and the memory expander 107 [are constructed of] operate according to the pixel difference encoding method. The memory compressor 105

and the memory expander 107 in Fig. 1 correspond to a memory compressor 21 and a memory expander 23 <u>as shown</u> in Fig. 4.

Referring <u>now</u> to Fig. 4, the memory compressor 21 is constructed [by comprising] <u>to include</u> a subtracter 201, a quantizer 202, a fixed-length [decoder] <u>encoder</u> 203, an inverse quantizer 204, and adder 205, and a predictor 206. The memory expander 23 is constructed [by comprising] <u>to include</u> a fixed-length decoder 207, an inverse quantizer 208, an adder 209, and a predictor 210.

An image to be compressed is supplied to the subtracter 201 as an input, and the subtracter 201 performs subtraction of this input signal and a predicted value supplied from the predictor 206, and supplies a prediction error to the quantizer 202.

The quantizer 202 performs quantization of the prediction error in accordance with the quantization control section 24, and supplies [it] <u>the result</u> to the fixed-length [decoder] <u>encoder</u> 203 and the inverse quantizer 204.

The fixed-length [decoder] <u>encoder</u> 203 encodes the quantized value and stores it in the frame memory 22. In the inverse quantizer 204, the adder 205 and the predictor 206, inverse quantization and local decoding are performed, and an output from the predictor 206 is supplied to the subtracter 201.

The memory access width control section 25 takes account of a compression ratio based on an occupied ratio of the frame memory 22, and applies bit allocation control to the quantization control section 24, which is in conformity with the [bit] number <u>of bits</u> of a memory access unit.

The quantization control section 24 performs quantization control in which memory access width information is added, and applies control to the quantizer 202 so that [an] information content generated for a single or a plurality of memory compression processing units or for every control unit of <u>the</u> memory compression [processing] <u>process</u> is [to be] equal to or less than the [bit] number <u>of bit</u> of a memory access unit.

In this embodiment, if the compression processing unit is assumed to be constant, a block of a single pixel or a plurality of m x n pixels [becomes to be a] <u>defines the</u> compression processing unit.

The memory expander 23 receives a compressed image from the frame memory 22, and performs expansion of the compressed image by applying expansion and inverse quantization thereto, and outputs the <u>resulting</u> image.

Next, an example will be explained[,] in which [one] memory access width control is realized. One quantizer having a fixed compression ratio is used for quantization of a prediction error. [In] <u>As</u> such [a case], in <u>the</u> case that [an] information content generated for a single or a plurality of memory compression processing units for every control unit of <u>a</u> memory compression [processing] <u>process</u> exceeds the [bit] number <u>of bits</u> of a memory access unit, a plurality of quantizers are prepared, and control is conducted so that the information content is in conformity with an access width. In this example, since an occupied content of the frame memory can be fixed, information from the frame memory is not required. In addition, an arrangement can be adopted[,] in which a plurality of quantizers having quantization characteristics different from each other share one quantization characteristic table.

On the other hand, in a case of orthogonal translation and so forth, it is different to fix [an] <u>the</u> information content generated for a single or a plurality of memory compression processing units or for every control unit [of] <u>in a</u> memory compression [processing] <u>process</u>. In such a case, use of an occupied content of the frame memory is convenient.

Next, [the] <u>a</u> second <u>preferred</u> embodiment of the present invention will be explained. In the above-described first embodiment, the access width control section 110 conducts control of the quantizer control section 109 using the access memory width and the occupied content of the frame memory.

Fig. 5 [is a view showing] <u>illustrates</u> an arrangement of the second

embodiment of the present invention. Referring to Fig. 5, in [the second] <u>this</u>

embodiment [of the present invention], the access width control section 110 receives

information from the inverse quantizer 102, and applies control to the quantization

5   control section 109, in which information included in a compressed stream is added,

in other words, in which information during quantization is added. Accordingly, by

taking account of the information of the compressed stream and a [relation]

<u>relationship</u> between positions on an image, and so forth, allocation of the

information content can be realized, which [makes] <u>improves</u> image quality [be

10   improved.]<u>.</u>

[As] <u>Using the present invention as</u> explained above, [in accordance with the

present invention,] <u>several</u> advantages are effected as described below.

[The] <u>A</u> first advantage of the present invention is that compression and

expansion processing [for] <u>on</u> the contents of the memory can be conducted with [a]

15   high speed.

The reason [thereof] <u>for this effect</u> is that, in the present invention, since

quantization control <u>is conducted on a number of bits</u> which is [to be] equal to or less

than the number of bits of a memory access unit [is conducted], a number of [a

memory access to]<u>access occurrences to the memory to extract</u> the compressed

20   image [necessary] for [the] expansion <u>thereof</u> is reduced.

[The] <u>A</u> second advantage of the present invention is that, by conducting

allocation control of [an] information content using the information included in the

compressed stream, [an] <u>pixel</u> error [of an pixel] can be suppressed and image

quality can be improved.

25   The reason [thereof] <u>for this effect</u> is that, in the present invention, by taking

account of the information of the compressed stream and a [relation] <u>relationship</u>

between positions on an image, and so forth, allocation of the information content can be realized, which [makes] <u>improves</u> image quality [be improved].

CLAIMS:

1. A moving picture decoding apparatus to which a compressed stream generated using an inter-frame prediction system is input, said apparatus [comprises] <u>comprising</u>:

    compression means for compressing a decoded image [when the signal is stored] <u>and storing the resulting compressed image</u> in storage means;

    expansion means for expanding a compressed image stored in said storage means;

    quantization control means for controlling quantization on compression in said compression means; and

    access width control means for controlling said quantization control means so that bit allocation control is conducted so as to be in conformity with the [bit] number <u>of bits</u> of an access unit of said storage means.

2. A moving picture decoding apparatus according to claim 1, wherein said access width control means comprises means for controlling said quantization control means so that the <u>number of</u> coded [bit number for] <u>bits of</u> one or a plurality of compression processing [units] <u>blocks of image processed in said compression means,</u> or for every control unit of compression processing is in conformity with the [bit] number <u>of bits</u> of an access unit of said storage means in case that the coded [bit] number <u>of bits</u> exceeds the [bit] number <u>of bits</u> of an access unit of said storage means or is lacking.

4. A moving picture decoding apparatus according to claim 1, [further comprising] <u>wherein said quantization control means controls quantization by preparing</u> a plurality of quantizers and a plurality of quantization characteristic tables.

5. A moving picture decoding apparatus according to claim 1, [further comprising] <u>wherein said quantization control means controls quantization by preparing</u> a plurality of quantizers and a quantization characteristic table being shared by said plurality of quantizers.

9. A moving picture decoding apparatus to which a compressed stream generated using an inter-frame prediction system is input, said apparatus [comprises] comprising:

compression means for compressing a decoded image;

storage means for storing a compressed image [in] output from said compression means;

expansion means for expanding the compressed image stored in said storage means;

quantization control means for controlling quantization on compression in said compression means; and

[said] access width control means for applying bit allocation control to said quantization control means so as to be in conformity with the [bit] number of bits of an access unit of said storage means, [and] wherein

said quantization control means controls quantization in said compression means based on access width information from said access width control means so that generated information content for one or a plurality of compression processing [units] blocks of the image processed in said compression means or for every control unit of compression processing is equal to or less than the [bit] number of bits of an access unit of said storage means in the case that the generated information content exceeds the [bit] number of bits of an access unit of said storage means or is lacking.

10. A moving picture decoding apparatus according to claim 9, wherein said access width control means applies bit allocation control to said quantization control means so as to be in conformity with the [bit] number of bits of an access unit of said storage means, based on an occupied content of said storage means.

12. A moving picture decoding apparatus according to claim 9, wherein said access width control means applies control to said quantization control means so that, compared with the [bit] number of bits of an access unit of said storage means, in the case that the [allocation bit] allocated number of bits of [a] coded data of a compression processing [unit] block exceeds

the [bit] number of bits of [an] the access unit of said storage means or is less than the [bit] number of bits of [an] the access unit of said storage means, the [allocation bit] allocated number of bits is conformed to be equal to or less than the [bit] number of bits of [an] the access unit of said storage means by subtracting a predetermined number of bits from the [allocation bit number of a] allocated bits of coded data of said compression processing [unit] block or by increasing the [allocation bit] number of allocated bits by the predetermined number of bits, whereby the coded data [can] is enabled to be [taken out by means of one access to] extracted from said storage means with one access occurrence.

13.   A moving picture decoding apparatus according to claim 9, wherein said compression means controls quantization [characteristic of quantizer] characteristics used for quantizing said decoded image, based on control [of] by said quantization control means.

14.   A moving picture decoding apparatus according to claim 9, [further comprises] wherein said quantization control means controls quantization by preparing a plurality of quantizers having quantization characteristics different from each other, and wherein a quantization characteristic table is shared by said plurality of quantizers.

15.   A moving picture decoding apparatus according to claim 9, wherein
       said compression means comprises a subtracter, a quantizer, an encoder, an inverse quantizer, an adder and a predictor,
              a prediction error [that is] obtained in said subtracter by a subtraction operation between said decoded image and a predicted value from said predictor is supplied to said quantizer,
              under control of said quantization control means, said quantizer quantizes said prediction error and supplies [it] the quantized result to said encoder and said inverse quantizer,
              said encoder encodes an output from said quantizer and outputs [it] the encoded result to said storage means, and

inverse quantization and local decoding are conducted in said inverse quantization, said adder, and said predictor.

17. A moving picture decoding method comprising the steps of:

detecting [the] a number of coded [bit number] bits for one or a plurality of compression processing [units] blocks of data or for every control unit of compression processing and controlling said number of coded [bit number] bits so that said number of coded [bit number] bits is in conformity with the [bit] number of bits of an access unit of a storage means when said detected number of coded [bit number] bits exceeds the [bit] number of bits of an access unit of said storage means or is lacking.

18. A moving picture of decoding method according to claim 17, wherein said step of controlling [comprise a step of controlling] comprises using information [included in the] from an external compressed data stream.